UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

(2)

REPOR

1a. REPORT SECURITY CLASSIFICATION
Unclassified

AD-A230 402

2a. SECURITY CLASSIFICATION AUTHORITY

)RT

"A" Approved for public release; distribution unlimited.

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
LMI-AC001R2

5. MONITORING ORGANIZATION REPORT NUMBER(S)

DTIC
ELECTE
JAN 03 1991
D
E

6a. NAME OF PERFORMING ORGANIZATION
Logistics Management Institute

6b. OFFICE SYMBOL *(If applicable)*

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS *(City, State, and ZIP Code)*
6400 Goldsboro Road
Bethesda, Maryland 20817-5886

7b. ADDRESS *(City, State, and ZIP Code)*

8a. NAME OF FUNDING / SPONSORING ORGANIZATION
Military Airlift Command

8b. OFFICE SYMBOL *(if applicable)*
MAC(TR)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
MDA903-90-C-0006

8c. ADDRESS *(City, State, and ZIP Code)*
Scott Air Force Base, IL 62225

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
Enhancing Aircraft Utilization: Improved Use of Cargo-Holding Time

12. PERSONAL AUTHOR(S)
Lawrence Schwartz

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Final	FROM _____ TO _____	1990 September	36

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
Military Airlift Command, aircraft utilization, cargo-holding time, required delivery date, UMMIPS, delivery quality

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

The Military Airlift Command (MAC) has incurred lower aircraft utilization rates since FY87. Aircraft efficiency has suffered as airlift demands of the Military Services declined, prompted by shrinking transportation budgets.

To improve its aircraft efficiency, MAC has experimented with extending the length of time it holds cargo at aerial ports of embarkation beyond the 48-hour limit set by the Uniform Materiel Movement Issue Priority System (UMMIPS). A statistical model shows that such cargo-holding time extensions can be a powerful tool for improving the utilization of its aircraft. Moreover, MAC found that timely deliveries need not suffer with cargo-holding time extensions: when Julian delivery dates are not constraining, MAC can use some of the extra time to extend its cargo-holding time; when Julian delivery dates are constraining, MAC can reduce its other possession times to compensate for the increased cargo-holding time; and when expeditious shipments are designated, MAC can focus on standard UMMIPS times.

MAC should be given formal managerial authority to focus on meeting the particular delivery requirement of each shipment, not on following currently arbitrary and uniform timeframes. To obtain and use this new authority, we recommend certain revisions to UMMIPS, modifications to MAC's operating procedures, and changes to performance reporting.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE *(Include Area Code)*

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ENHANCING AIRCRAFT UTILIZATION: IMPROVED USE OF CARGO-HOLDING TIME

Report AC001R2

September 1990

Lawrence Schwartz

LOGISTICS MANAGEMENT INSTITUTE
6400 Goldsboro Road
Bethesda, Maryland 20817-5886

Executive Summary

ENHANCING AIRCRAFT UTILIZATION: IMPROVED USE OF CARGO-HOLDING TIME

Since FY87, declining transportation budgets for the Military Services have resulted in a 30 percent reduction in the amount of cargo moved by the Military Airlift Command (MAC), while available aircraft capacity has remained relatively constant. The result is sharply lower aircraft utilization rates.

To increase the utilization of its aircraft, MAC has experimented with extending the length of time it holds cargo at aerial ports of embarkation. In FY89, for example, MAC increased the average cargo-holding time from 48 to 55 hours, worldwide, raising aircraft utilization by nearly 3 percentage points. To achieve that increase in cargo-holding time without jeopardizing the timeliness of its service, MAC often reduced, by comparable amounts, the intransit time and/or the processing time at the aerial ports of debarkation.

Our analysis of MAC's experience with extended cargo-holding times shows that accumulating cargo at aerial ports can be a powerful tool for increasing aircraft utilization, but the existing Uniform Materiel Movement Issue Priority System (UMMIPS) standards do not provide MAC with the necessary flexibility to use cargo-holding time effectively. Although formally proposed changes to UMMIPS will, if implemented, give MAC some additional flexibility, they do not go far enough. We believe that UMMIPS needs to undergo further change, focusing on meeting the particular delivery requirement of each shipment, not on uniform standards. Such a change will also have an impact on MAC's operations.

We recommend the following actions as key steps toward strengthening MAC's airlift operations:

- *Revise UMMIPS.* The Assistant Secretary of Defense (Production and Logistics) should issue a policy memorandum directing that greater emphasis be placed on meeting required delivery dates and authorizing MAC more time, flexibility, and responsibility in managing its portion of the logistics pipeline. MAC has found that both higher aircraft utilization and

timely deliveries are attainable if it focuses on meeting required delivery dates.

- *Modify operating procedures.* MAC should modify its operating procedures so that meeting required delivery dates is the airlift managers' primary focus. The modified procedures should distinguish among shipments with expeditious delivery requirements, specified delivery dates, and basic airlift requirements.

- *Revise performance reporting.* The Assistant Secretary of Defense (Production and Logistics) and MAC, jointly, should develop a reporting mechanism to monitor MAC's performance on the basis of delivery times. Such performance should be based upon a combination of measures, including shipment receipt dates, required delivery dates, and UMMIPS times.

We believe that these actions will enable MAC to make more efficient use of its aircraft and provide more timely delivery, thereby both reducing the overall cost of DoD's logistics system and improving its performance.

CONTENTS

CHAPTER 1

CARGO AIRLIFT ENVIRONMENT

INTRODUCTION

From FY82 through FY87, Military Airlift Command (MAC) aircraft routinely operated at a minimum of 70 percent of the available cabin load, registering rates as high as 80 percent in some months. In FY88 and FY89, however, those utilization rates fell to about 62 percent annually, with some months as low as 55 percent.

Military Airlift Command's aircraft utilization rates decreased for two primary reasons. First, the Military Services received only 90 percent of their requested transportation funding for both FY88 and FY89, and as a result they reduced the amount of cargo moved by air. Second, MAC's flying hour program, which generates much of the peacetime aircraft capacity, remained somewhat immune to reduction.

Among the many actions MAC has taken to improve aircraft capacity utilization are the following:

- It instituted a new payment mechanism to make Frequency Channels (routes flown on a regular schedule) more efficient without impairing readiness.[1]
- It recently began implementing the recommendations of the *Optimal Airlift Distribution Study* by MAC, which was aimed at streamlining MAC's airlift system.
- It reduced the "expansion buy" of the Civil Reserve Air Fleet (CRAF) to increase the amount of cargo available for movement by organic airlift.
- It extended aerial port of embarkation (APOE) cargo-holding times to increase aircraft utilization.

The fourth action, extending cargo-holding time, has the potential to substantially increase aircraft utilization. However, it cannot be implemented in isolation. In this report, we examine MAC's experience with various cargo-holding

[1]See Schwartz, Lawrence, *Improving Military Airlift Efficiency: New Frequency Channel Charging*, LMI Report AC001R1, Bethesda, Maryland, May 1990.

times and present several ideas for maximizing its contribution to increased aircraft utilization.

TECHNICAL RELATIONSHIPS

To realize the full potential of longer cargo-holding times, MAC needs to reduce aircraft capacity and/or increase organic cargo movements. Figure 1-1 illustrates the relationships among these variables; Appendix A develops their technical underpinnings.

Extending cargo-holding time (the vertical axis of Figure 1-1) reduces the aircraft capacity (the horizontal axis) required to move a given level of cargo (represented by the curves). For example, MAC could move Level 1 cargo with an aircraft capacity of AC_a and a cargo-holding time of CH_a. Alternatively, it could move that same amount of cargo by increasing cargo-holding time to CH_b and reducing aircraft capacity to AC_b. This phenomenon occurs because longer cargo-holding times permit more cargo to be accumulated for movement on fewer aircraft (and, thus, reduced aircraft capacity), thereby increasing aircraft utilization.

Figure 1-1 also shows that if MAC wants to improve aircraft efficiency, it may need to generate more organic cargo as well as increase cargo-holding time. To illustrate: If aircraft capacity is held level at AC_a (rather than being reduced to AC_b), cargo-holding time must be increased from "a" to "c," and at the same time, organic cargo also must be increased from Level 1 to Level 2. If Military Service transportation budgets remain tight, then MAC needs to increase the amount of cargo moved organically either by lowering its rates or reducing the amount of cargo allocated to CRAF.

PERFORMANCE CRITERIA

Department of Defense (DoD) Directive 4410.6, *Uniform Materiel Movement and Issue Priority System (UMMIPS)*, October 1980, designates the time standards for moving cargo from materiel requisition to receipt. Table 1-1 shows the current UMMIPS time standards for high-priority cargo (TP-1) to Europe by pipeline segment. It also shows proposed changes to those standards as well as additional changes now being discussed.

Although the three versions of the UMMIPS standards specify the same 12 days, they provide DoD logistics managers with different degrees of flexibility.

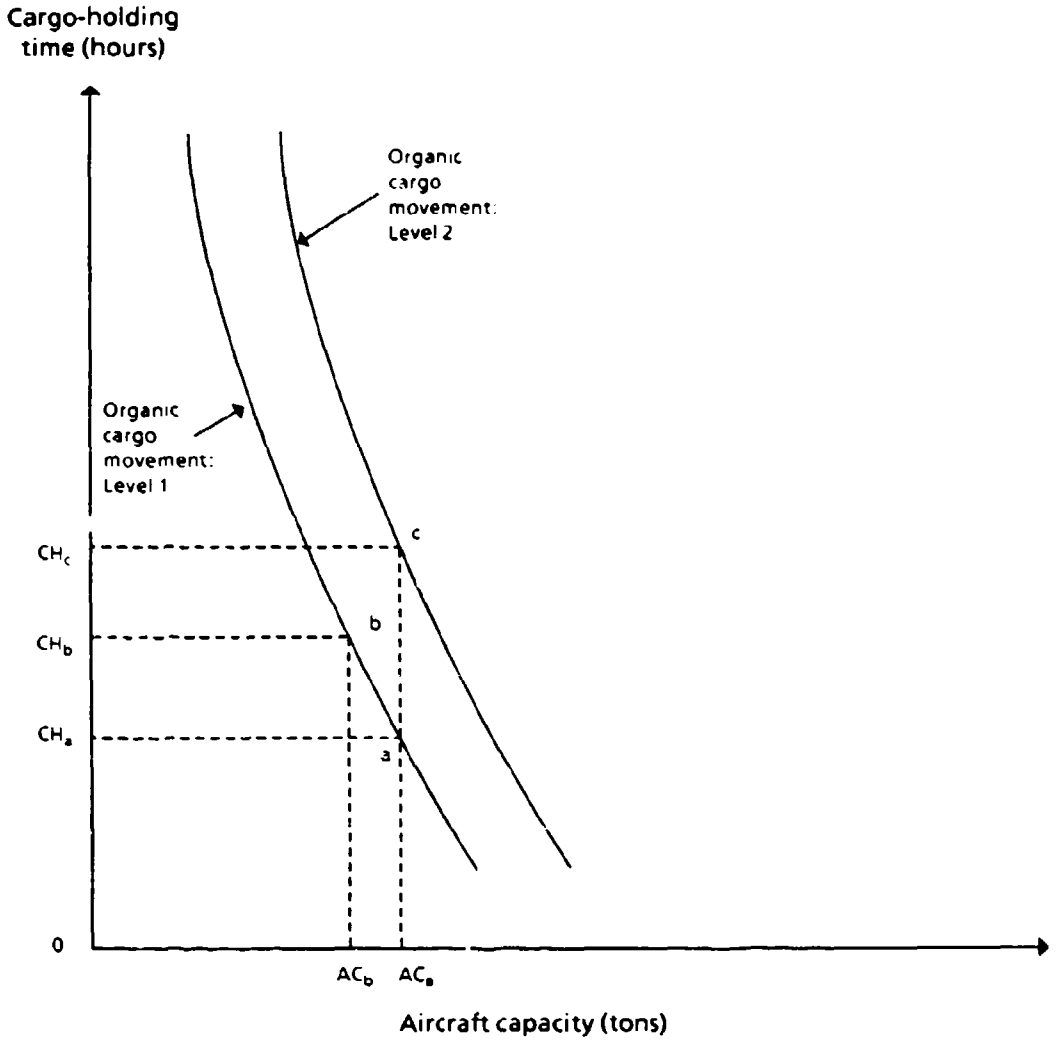

FIG. 1-1. CONTEXT FOR MAKING CARGO-HOLDING TIME CHANGES

First, both the proposed and recently discussed versions compress the times for requisition submission and passing action (Segments 1 and 2) from 2 days to 1 day. Second, both the proposed and discussed versions add 1 day to the time (from 4 to 5 days) for APOE processing, intransit overseas, aerial port of debarkation (APOD) processing, and intratheater intransit collectively (Segments 6 through 9). Third, while the proposed version would restrict MAC and intratheater intransit managers to fixed time limits on their segments, the discussed revision would force MAC to make better use of the 4 days. Finally, the proposed and discussed versions would

TABLE 1-1

UMMIPS TIME STANDARDS FOR TP-1 EUROPEAN SHIPMENTS

(Elapsed calendar days)

Pipeline segment	Current	Proposed	Discussed
1. Requisition submission	1	1	1
2. Passing action	1		
3. Inventory control point availability determination	1	1	1
4. Depot/storage site	1	4	4
5. CONUS intransit	3		
6. APOE processing	4	2	4
7. Intransit overseas		1	
8. APOD processing		1	
9. Intratheater intransit		1	1
10. Receipt by requisitioner	1	1	1
Total order-ship time	12	12	12

Source: Office of the Secretary of Defense.

Notes: CONUS = Continental United States; TP-1 = Transportation Priority-1

provide a fifth, separate day to intratheater intransit managers, recognizing that segment as a separate portion of the transportation pipeline.

The discussed UMMIPS revision would give MAC greater overall managerial responsibility for airlift. It would enable MAC to extend APOE cargo-holding times to improve aircraft utilization; it would also place greater responsibility on MAC to meet required delivery dates (RDDs). When the RDDs are not constraining, MAC could extend its cargo-holding times accordingly. In circumstances with constrained delivery dates, MAC would need to offset increased APOE cargo-holding times by decreasing other possession times to achieve both increased aircraft utilization and timely delivery. With expeditious delivery requirements (i.e., "999" code designated

in RDD field), MAC would have little flexibility with its transportation pipeline segments.

Management by delivery time is now feasible within DoD. Until very recently, a majority of DoD requisitions and release orders left the RDD field blank, thereby making it difficult for MAC to manage its transportation operations by delivery times. DoD policy now requires that all priority requisitions must have a completed RDD field to receive priority attention.[2]

In the following chapter, we describe MAC's experience with increased cargo-holding times and assess the effects of those increases on aircraft utilization and delivery quality.

---

[2]From March 1988 through October 1989, the RDD field was blank in 56 percent of all airlift shipments. Beginning 1 May 1990, DoD policy requires that the RDD field contain either 999 to identify critical requisitions, a specified delivery date, or "777" to denote priority processing. If none of those conditions is met, the shipment moves by sealift.

Although MAC has not fully implemented procedures to accommodate the new RDD policy, some shippers already have responded. CONUS-outbound shipment documents now show fewer RDDs with blanks, down from 50 percent in the period from June 1989 through August 1989 to 44 percent in the comparable period in 1990.

CHAPTER 2

CARGO-HOLDING TIME EXPERIMENTATION

The Military Airlift Command has been experimenting with extending cargo-holding times since the middle of FY87, when DoD components began to decrease the amount of materiel they shipped by airlift. To assess the full effect of longer cargo-holding times on MAC's performance, we examined, using a statistical model, the impact of APOE cargo-holding time on aircraft utilization. We also analyzed the effect of cargo-holding time on the timeliness of MAC deliveries.

MAC'S EXPERIMENT WITH CARGO-HOLDING TIME

Table 2-1 shows the APOE cargo-holding times used by MAC in FY88 and FY89 for each of four geographical areas and for combined retrograde and intratheater movements. (Note that MAC's operating areas are not the same as those in the current UMMIPS directive, which considers Area 4 part of Area 3.)

Table 2-1 shows that MAC has extended its APOE cargo-holding times (from the UMMIPS standard) by different amounts depending upon the area. For Areas 2 and 4, MAC increased cargo-holding times by as much as 46 percent, from 48 hours to about 70 hours. In contrast, for Areas 1 and 3 as well as for retrograde and intratheater movements, MAC extended cargo-holding times more modestly, by 15 percent or from 48 to as much as 55 hours. These differences reflect a number of considerations, including mission frequencies, cargo tonnages, and delivery times. On a worldwide basis, MAC's average cargo-holding time during this period was approximately 55 hours.[1]

[1]Area 3 and retrograde and/or intratheater reduce the average worldwide cargo-holding time because of their small increases in cargo-holding times and relatively large cargo tonnages.

TABLE 2-1

APOE CARGO-HOLDING TIMES

Cargo movement	Cargo-holding time (hours)	
	FY88	FY89
CONUS outbound		
Area 1	55	53
Area 2	67	70
Area 3	53	55
Area 4	65	67
Retrograde/intratheater	55	53
Worldwide average	56	54

Source: MAC

Note: Area 1 includes Alaska, Hawaii, Guam, Caribbean, and Central America. Area 2 includes the United Kingdom and Northern Europe. Area 3 includes Japan, Okinawa, Korea, The Philippines, and Western Mediterranean, and Area 4 includes all other destinations, many of which have difficult airlift requirements. The average is weighted by the amount of tonnage moved.

EFFECT ON AIRCRAFT UTILIZATION

The statistical model we used to estimate the effect of cargo-holding time on aircraft utilization was constructed without reference to geographical area.[2] To isolate the desired cargo-holding effect on utilization, we established statistical controls for various outside influences, such as budgetary changes. Appendix A describes the technical development of the model in more detail.

The model shows that for every 10 percent increase in worldwide APOE cargo-holding time, MAC would increase aircraft utilization by about 2 percent (holding other factors constant). The implications of this finding are summarized in Table 2-2. Extending worldwide cargo-holding times from an average of 48 hours to 55 hours (a 15 percent increase) would increase aircraft utilization by almost 3 percentage points, which is consistent with MAC's experience during FY88 and FY89. If MAC increases its cargo-holding time to 60 hours, worldwide, the model shows that aircraft

[2]We could not develop an area-specific model because MAC does not track aircraft utilization by area, only by particular aircraft on a worldwide basis.

utilization would increase by more than 4 percent. Increasing worldwide cargo-holding times beyond 60 hours would require even greater contractions to MAC's other possession times, which may not be possible.

TABLE 2-2

EFFECT OF CARGO-HOLDING TIME ON AIRCRAFT UTILIZATION

Cargo-holding time (hours)	Percent change from 2-day standard	Aircraft utilization (% increase)
55	15	2.6
60	25	4.3
65	35	6.0
70	45	7.6

EFFECT ON DELIVERY QUALITY

Since many shipments have constrained delivery times, MAC can extend cargo-holding times only by shortening either the time required to move the materiel overseas (i.e., the intransit time) or the time required to process it through the APOD. Table 2-3 summarizes how MAC responded to increased cargo-holding times in FY89 for the four CONUS-outbound areas (as defined in the note to Table 2-1). In Area 2, for example, although MAC extended FY89 cargo-holding time from 2 to 2.9 days (22 hours), it offset much, but not all, of that increase by reducing intransit overseas time from 1 to 0.8 days (5 hours) and average APOD processing time from 1 to 0.4 days (15 hours). In each of the other areas, MAC also compensated for increased cargo-holding times largely by reducing APOD processing times.

Actual Performance

To provide a more comprehensive assessment of the timeliness of MAC's service, we also analyzed the records of 1.5 million airlift movements that occurred between March 1988 and October 1989.[3] According to those records, MAC had three

[3]The airlift records were provided by the Defense Automated Addressing Systems Office, Tracy, California.

TABLE 2-3

MAC TRANSPORTATION PIPELINE MANAGEMENT: FY89

(Number of days)

Pipeline segment	Cargo-holding time in CONUS areas (days)			
	Area 1	Area 2	Area 3	Area 4
Cargo holding	2.2 (2.0)	2.9 (2.0)	2.3 (2.0)	2.8 (2.0)
Intransit overseas	0.7 (1.0)	0.8 (1.0)	2.0 (2.0)	1.6 (2.0)
APOD processing	0.5 (1.0)	0.4 (1.0)	0.3 (1.0)	0.1 (1.0)
Total time	3.4 (4.0)	4.1 (4.0)	4.6 (5.0)	4.5 (5.0)

Source: MAC.

Note: UMMIPS standard in parentheses.

different types of shipments as indicated by the entry in the RDD field: those with a Julian date; those with 999 (i.e., an expeditious shipment); and those with a blank.

For shipments with a Julian date in the RDD field, MAC's performance was excellent. Only 2 percent of more than 400,000 delivery-dated shipments (representing 28 percent of the total shipments) were late. In contrast, earlier stages in the logistics pipeline caused 16 percent of those shipments to be late.[4] During this 20-month period, 82 percent of all Julian-dated shipments were delivered on or before they were required.

For shipments with 999 in the RDD field, MAC failed to meet DoD's delivery requirements (i.e., the UMMIPS standard) on 17 percent of the 240,000 expeditious shipments during this period. MAC needs to continue to improve its performance on these shipments.

We were unable to assess the delivery quality of shipments that had a blank in the RDD field (more than 800,000 of the 1.5 million shipments). However, the

[4]If MAC received shipments with adequate time for processing (e.g., 4 days to Europe) but missed the RDD, we attributed the lateness to MAC. If, however, MAC received shipments with inadequate time for movement (such as less than 2 days to Europe), we assigned the lateness to earlier segments in the pipeline.

Assistant Secretary of Defense (Production and Logistics) [ASD(P&L)] recently directed, in a 1 May 1990 policy memorandum, that the RDD field specify either a Julian date, expedite (999), or 777 to indicate premium transportation. If none of those conditions is met, the shipper will face routine processing or sealift.

Perceived Performance

We also sought a different perspective on airlift performance: Did MAC meet its customers' needs? To obtain that perspective, we sent a questionnaire to the following organizations:

- Commander-in-Chief, Atlantic Fleet
- Commander-in-Chief, Pacific Fleet
- Pacific Air Forces
- U.S. Air Forces Europe
- U.S. Army Europe.

We requested that each of these organizations direct the questionnaire to 5 percent of its units – representing cargo, personal property, security assistance, and other major types of shipments. Appendix B contains a copy of the questionnaire.

Some of the organizations and units responded without qualification, others indicated that they did not have a formal tracking system with which to judge the quality of MAC's deliveries, and yet others indicated that their responses were based upon perceptions. Overall, the respondents indicated that MAC shipments were late in meeting required delivery only a very small percentage of the time (2 percent or less), which is consistent with the actual delivery quality for such shipments. None of the respondents provided case histories of late shipments.

SUMMARY

The Military Airlift Command managed its portion of the logistics pipeline quite well when it extended average cargo-holding time, worldwide, to 55 hours. The additional holding time permitted MAC to increase aircraft utilization by approximately 3 percentage points. To maintain quality delivery service, MAC compensated by shortening other possession times, particularly APOD processing, which resulted in only 2 percent of all shipments with specified RDDs being late. MAC's performance with expeditious shipments, however, was not nearly as effective. New

DoD policy, requiring explicit use of RDDs or priority designations, should be of substantial value to MAC in formulating its operating procedures to meet customers' needs more closely.

CHAPTER 3

NEW OPERATIONAL FOCUS

The MAC experiment with extending cargo-holding times shows that better management can result in increased aircraft utilization without any adverse effect on delivery performance. It also suggests that managing strictly by UMMIPS standards may be counterproductive. In this chapter, we lay out several new operating concepts for MAC, building upon the findings presented in the preceding chapter.

DELIVERY-DATED SHIPMENTS

During FY89, MAC increased its average worldwide cargo-holding time from 48 to 55 hours, improving worldwide aircraft efficiency by almost 3 percentage points, while maintaining its on-time performance for shipments with specified delivery dates (Julian dates) at about 98 percent. Yet, for those same shipments, MAC met the UMMIPS time standards an average of only 67 percent of the time. Table 3-1 shows MAC's FY89 performance in meeting RDDs and UMMIPS standards.

TABLE 3-1

FY89 MAC MOVEMENT PERFORMANCE

(Percent)

Type of shipment	Met RDD	Met UMMIPS standard
Specified date	98	67
Expedited	——a	80

Source: MAC.

a Since a delivery date is not specified for expeditious shipments, UMMIPS is the relevant basis for monitoring on-time delivery performance.

It would be inappropriate for MAC to focus on increasing the percentage of time that it met UMMIPS standards for the shipments with specified delivery dates. Such a focus would hamper MAC's ability to increase cargo-holding times to improve aircraft utilization. It also would result in many shipments arriving before the delivery requirement set by the customer, negating many of the benefits of airlift.

EXPEDITIOUS SHIPMENTS

For expeditious shipments, UMMIPS specifies the maximum time that MAC can hold, move, and process cargo. As shown in Table 3-1, MAC has met the UMMIPS standard more often for expeditious shipments than for delivery-dated shipments (80 percent versus 67 percent). To make additional improvements in on-time performance of expeditious shipments, MAC has recently introduced some new policies and procedures and is considering others.

In FY90, MAC began differentiating between the movement of expeditious and other shipments in its operating procedures. At CONUS APOEs, MAC placed expeditious shipments on separate pallets as much as possible and gave those pallets higher movement priority than pallets containing regular shipments. These changes increased the percent of time that MAC met the UMMIPS standards from an average of 80 percent in FY89 to 83 percent in FY90 (through May 1990).

The Military Airlift Command also developed a new service concept for packages under 101 pounds. Since 1 March 1990, Emery, Inc., has been providing door-to-door delivery of such packages under a MAC contract. MAC has developed delivery time standards for every route and Emery is expected to meet those standards 95 percent of the time. The cost of this service is relatively high, reflecting the added expense of providing door-to-door service, higher aircraft capacity requirements, and more intensive operations. MAC is now conducting a full evaluation of this concept and may expand it to the movement of heavier expeditious cargo with organic aircraft.

REPORTING PERFORMANCE

If its operating focus changes, MAC's reporting requirements would also need to change. For expeditious shipments, MAC's performance is measured by the percentage of time it meets UMMIPS standards. MAC may want to establish an internal goal for meeting UMMIPS standards on expeditious shipments, perhaps

90 or 95 percent of the time, and use that goal to bring about additional policy and procedural changes, as necessary, to improve delivery performance even further.

For delivery-dated shipments, MAC's performance should be based upon meeting the RDDs. We believe that MAC should report both the percentage of time (incidence) and the average number of late days (extent) that shipments do not meet the delivery date. The following reporting rules may have application:

- When MAC receives a shipment and does not have enough time to meet the delivery date (according to UMMIPS), then it should not be assigned responsibility for the shipment being late. However, if MAC adds to the lateness, then that inadequate performance should be reported.
- When MAC receives a shipment with sufficient time to meet the delivery date (according to UMMIPS), then those late deliveries (from APOEs through APODs) should be attributed to MAC.
- The total lateness, in terms of both incidence and extent, should be calculated by combining the above results.

UMMIPS ROLE

If MAC adopted this new operational focus for monitoring its performance, then its use of UMMIPS would be somewhat more limited. As described in the previous section, MAC would use UMMIPS to help assess its performance for Julian-dated shipments, it would continue to use UMMIPS as the standard for moving expedited shipments, and it would use UMMIPS reporting for establishing operating norms.

The UMMIPS times themselves would also need to change. We recently discussed some proposed UMMIPS changes with representatives from the Office of the Assistant Secretary of Defense (Production and Logistics) and MAC. Those changes are presented in Table 3-2.

Under the proposed changes, UMMIPS areas also would change. Area 4 should be redefined and provided with more time to include all difficult airlift destinations; now it is part of Area 3. If MAC reported its performance separately for Areas 3 and 4, it would be more meaningful. Also, Area 1 should include North Atlantic (previously part of Area 4) and Area 3 should include Guam (now part of Area 1).

The new UMMIPS times would mean that MAC operations also would need to change. Its times, differentiated only by geographical area, would not include the time for intratheater intransit, which would be specified separately. Those changes

TABLE 3-2

PROPOSED TRANSPORTATION PIPELINE TIMES BY AREA

(Elapsed calendar days)

Cargo movement (to or from)	MAC possession time	
	Proposed requirement	FY89 actual
Area 1	4.0	3.4
Area 2	4.0	4.1
Area 3	5.0	4.6
Area 4	8.0	4.5
Tonnage-weighted average	4.8	4.3

Note: Some Frequency Channels have very few flights per month, which would prohibit MAC from meeting the UMMIPS standards for shipments on those flights. MAC should report on those shipments separately. The four areas are basically defined in Table 2-1; changes are described in the text.

would permit MAC to increase CONUS cargo-holding times by an average of 12 hours and worldwide cargo-holding times from 55 to 60 hours, further enhancing aircraft utilization.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Since FY87, MAC's aircraft utilization has decreased dramatically, which has contributed to increased difficulty in funding training requirements. In response, MAC has experimented with extending APOE cargo-holding times to improve aircraft efficiency. It has increased APOE cargo-holding times, worldwide, by nearly 15 percent, from an average of 48 hours to 55 hours. That action has improved aircraft utilization by almost 3 percentage points. At the same time, MAC has been stressing its customers' delivery requirements, a focus that is much better than meeting the UMMIPS uniform standards. MAC needs more formal authority to make such changes.

Recommendation. *The ASD(P&L) should issue a policy memorandum directing MAC to place greater emphasis on meeting RDDs and authorizing expanded flexibility and responsibility for managing its portion of the logistics pipeline.*

A proposed revision to the UMMIPS standards provides an additional transportation pipeline day for MAC and intratheater intransit managers combined, while reducing the pipeline segment time of requisition submission and passing action by an equal amount. MAC's possession times would be separated from those of the intratheater intransit managers, with the total UMMIPS pipeline time unchanged. The proposed UMMIPS revision, however, does not appear to be forthcoming.

Recommendation. *The ASD(P&L) should issue a policy memorandum authorizing MAC additional time in the logistics pipeline, separate from that of intratheater intransit managers, while holding total order-ship times constant.*

We propose that DoD adopt the possession times shown in Table 4-1.

To implement the additional movement time, MAC needs to change its management focus. For shipments with specified delivery dates, MAC should extend cargo-holding time as long as practical to meet the RDD, thereby maximizing aircraft utilization. When the delivery requirement is constraining, MAC should reduce its

TABLE 4-1

PROPOSED TRANSPORTATION TIMES BY AREA

(Elapsed calendar days)

Cargo movement (to or from)	Transportation time		
	MAC	Intratheater	Total
Area 1	4.0	1.0	5.0
Area 2	4.0	1.0	5.0
Area 3	5.0	1.0	6.0
Area 4	8.0	1.0	9.0

Note: See Table 2-1 and text in Chapter 3 (p. 3-3) for area definitions.

other possession times to offset any increase in cargo-holding time. Since UMMIPS continues to set the delivery requirements for expeditious shipments, MAC does not need to change its focus for those shipments. We believe that MAC needs new operating procedures and performance reporting to meet this new focus on delivery times.

Recommendation. *MAC should modify its operating procedures so that meeting RDDs is the primary focus for airlift managers. The operating procedures should distinguish a g shipments with expeditious delivery requirements, specified delivery date nd basic airlift requirements.*

Recommendation. *The ASD(P&L) and MAC, jointly, should develop a reporting mechanism to monitor MAC's performance based upon a combination of measures, including shipment receipt dates, RDDs, and UMMIPS times.*

To improve its on-time performance for expeditious shipments, MAC has introduced several new policies and procedures. In FY90, it segregated expeditious shipments from other routine airlift shipments; placed the expeditious shipments on separate pallets, whenever possible; and gave these pallets higher priority for movement. Those actions raised MAC's on-time record for all expeditious shipments from 80 percent in FY89 to 83 percent for the first several months of FY90. Moreover, since 1 March 1990, MAC has contracted for door-to-door, 95-percent on-time service for packages under 101 pounds, but the full effects of this service have

not been assessed. A similar concept may have application in MAC's organic operations for heavier, expeditious shipments.

Recommendation. *MAC should explore the possibility of developing a special expeditious service to improve the delivery quality of heavier, more urgent cargo.*

Although extending cargo-holding times has great potential for improving aircraft utilization, its success is dependent upon the steady flow of cargo into the APOEs and/or the reduction of peacetime cabin-load capacity. Lower transportation budgets have reduced the amount of airlift cargo, making it more difficult for MAC to obtain the full benefits of cargo-holding time extensions. As a result, MAC may need to reassess the amount of cargo allocated to CRAF commercial airlift. Also, with the emerging strategic requirements, MAC may need to reduce its organic peacetime capacity, which would change the effects of cargo-holding time extensions on aircraft utilization substantially.

Recommendation. *MAC, in conjunction with the ASD(P&L), should undertake a comprehensive review of wartime and peacetime airlift requirements to reconcile both strategic and efficiency concerns.*

We believe that, taken together, these changes will give MAC the authority, capability, and focus for substantially increasing aircraft efficiency and customer service.

APPENDIX A

CARGO-HOLDING TIME MODEL

This appendix describes the model that we formulated to examine the effects of cargo-holding time on aircraft utilization. It also outlines the data for measuring the variables of the model, presents the statistical results obtained from applying the model, and draws implications from those results.

THE MODEL

The theoretical effects of changing cargo-holding times can best be understood in an operational context. A given amount of cargo can be moved by various combinations of aircraft capacity and cargo-holding times. For example, longer cargo-holding times would reduce the amount of aircraft capacity required to move a given amount of cargo, which would decrease aircraft capacity costs. To realize those cost reductions, however, the flying hour program would have to be reduced coincidentally.

If aircraft capacity is fixed, then the role of cargo-holding time extensions would be more limited. Increasing cargo-holding times would facilitate the movement of additional cargo, provided aircraft are not already fully utilized. In today's fiscal environment, however, the generation of cargo has become exceedingly difficult because of reduced transportation budgets.

Equation A-1 is a mathematical representation of the above relationship. For ease of mathematical manipulation and interpretation, Equation A-1 is expressed in linear form. It shows that cargo movement (CM) is a function of aircraft capacity (AC), cargo-holding time (CH), and transportation budgets (TB). The coefficient for both aircraft capacity, b, and cargo-holding time, c, should be positive, signifying that increases in either would increase the amount of cargo moved. Declining transportation budgets should have a depressing effect on cargo movement, resulting in a negative "e" coefficient.

$$CM = a + b \times AC + c \times CH + e \times TB \qquad \text{[Eq. A-1]}$$

From Equation A-1, we can also show the quantitative tradeoff between aircraft capacity and cargo-holding time to move a given amount of cargo. Differentiating Equation A-1 yields Equation A-2:

$$d(CM) = b\,d(AC) + c\,d(CH) + e\,d(TB) \qquad \text{[Eq. A-2]}$$

To determine the tradeoff between capacity and holding time, we need to hold cargo movement constant. We can achieve this mathematically by setting $d(TB)$ and $d(CM)$ equal to zero, and then solving for the tradeoff between aircraft capacity and cargo-holding time, as shown in Equation A-3.

$$d(CH)/d(AC) = -b/c \qquad \text{[Eq. A-3]}$$

Thus, the Military Airlift Command (MAC) can meet a given level of cargo movement by reducing aircraft capacity and increasing cargo-holding times according to the ratio $-b/c$.

The model can also be used to show the elasticity of aircraft utilization with respect to cargo-holding time. That elasticity can be derived by dividing Equation A-1 by AC, taking the partial derivative of aircraft utilization with respect to cargo-holding time, and dividing each partial derivative by the mean (sample) values of the respective variables. The result is shown in Equation A-4.

$$\textit{Aircraft utilization: cargo-holding time elasticity} = c \times \overline{CH}/\overline{CM} \qquad \text{[Eq. A-4]}$$

THE DATA

The definition, measurement, and symbolic representation of each variable in the model are described in this section. The data are expressed in monthly summaries for the period October 1985 through September 1989 (48 observations).

Aircraft Capacity (*AC*)

We define cargo capacity of the aircraft as the available cabin load. Although other measures of aircraft capacity are used, we believe that our definition is most appropriate for measuring overall aircraft efficiency.[1] The available peacetime cabin

[1]Another frequently used definition of cargo capacity is the concept of the "goal," which reduces the available cabin load by various operating constraints, such as fuel requirements for longer flights. However, we had only 2 years of historical goal data available, and that is much too short a time series for modeling.

load is expressed as an index number, with worldwide tonnage in October 1985 equal to 100.

Cargo Movement (*CM*)

We define cargo movement as the total worldwide, outbound cargo traffic, including tonnage from the aerial port of embarkation and intermediate legs. It is measured as an index number with tonnage in October 1985 equal to 100. MAC also uses another concept of cargo movement that excludes tonnages from intermediate legs. We believe that the more comprehensive measure of cargo movement is most appropriate for determining overall aircraft utilization.

Cargo-Holding Time (*CH*)

Prior to FY88, MAC used 48 hours as the standard cargo-holding time. Since then, it has varied cargo-holding time for outbound, intratheater, and retrograde shipments. To match the worldwide data that are available for aircraft capacity and cargo movement, we aggregated cargo-holding hours by weighting each area's cargo-holding time by its relative tonnage.

Second-Destination Transportation Budgets (*TB*)

Since FY87, the Military Services' second-destination transportation funds have been inadequate to meet their transportation requirements. This funding shortfall has substantially reduced demands for MAC's services. In our model, we used a "dummy" variable to represent this changing budgetary environment: 0 if the movement occurred on or before FY87 and 1 if the movement occurred after FY87.

MODEL RESULTS

We estimated the parameters of the model, a, b, c, and e, using regression analysis.[2] Although we estimated both linear and logarithmic forms, we found the linear form to be best with an adjusted $R^2 = 0.81$.

Equation A-5 presents the regression results. Positive autocorrelation was not a serious problem as the first-order autocorrelation coefficient was 0.27 and the Durbin-Watson statistic was 1.44. As a result, we can use the t-statistics (shown in

[2]We used ordinary least squares. For a general reference on this technique, see Kmenta, J., *Elements of Econometrics*, Macmillan Publishing Co., Inc., New York, 1971.

parentheses below each coefficient in Equation A-5) to indicate whether the coefficient of each variable is significantly different from zero. As Equation A-5 shows, all of the variables are significant because their t-statistics exceed the critical t-statistic of 2.01 (in absolute terms) at the 95 percent confidence level for 48 observations.

$$CM = 3.08 + 0.78 \times AC - 10.25 \times TB + 0.15 \times CH \qquad \text{[Eq. A-5]}$$
$$(+0.36)\ (+7.94)\quad (-6.53)\quad (+2.39)$$

From Equation A-5, we can derive three important results. First, according to the coefficient for *TB*, lower transportation budgets have resulted in a 10 percent reduction in cargo movement (relative to October 1985) every year since FY87 or a 30 percent reduction in MAC workload over the past 3 fiscal years.

Second, for every 5.2 hours of additional cargo-holding time, MAC could potentially reduce its worldwide aircraft capacity by about 700 tons. This result is obtained by calculating the tradeoff between aircraft capacity and cargo-holding time to meet a given level of cargo movement. The tradeoff, obtained from Equation A-3, is given by the coefficient of *AC* relative to the coefficient of *CH* (-0.78/0.15) or -5.2. Then, increasing cargo-holding time by 5.2 hours could reduce capacity by one unit on the October 1985 index (i.e., 700 tons).

Third, for every 10 percent increase in cargo-holding time (e.g., from 48 hours to 53 hours), MAC could increase aircraft utilization by 1.7 percent. This result is obtained by calculating the elasticity of aircraft utilization with respect to cargo-holding time. From Equation A-4, the coefficient of cargo-holding time, 0.15, is multiplied by the mean cargo-holding time and divided by the mean cargo-movement level over the 48 months ending FY89 [$0.15 \times (108.6/94.7) = 0.17$].

APPENDIX B

SHIPMENT TIMELINESS QUESTIONNAIRE

This appendix presents the complete questionnaire that was sent to several major commands soliciting their experience with the quality and timeliness of Military Airlift Command (MAC) deliveries during FY88 and FY89.

INSTRUCTION

Your unit has been selected to assist the Logistics Management Institute (LMI), Bethesda, Maryland, in an assessment of MAC's experimentation with its shipping-possession times. Experimentally, MAC has increased its aerial port of embarkation cargo-holding times to enhance aircraft utilization, while it decreased other possession times, mindful of your delivery requirements.

The central question is: How, if at all, have your delivery times been affected by such changes in procedure? The attached, brief questionnaire is designed to answer that question.

If you need any clarification or further information about the questionnaire, feel free to contact Larry Schwartz, LMI – 301-320-7276. Please FAX your completed questionnaire to LMI, 301-320-5617, by [various dates].

Thank you, in advance, for your cooperation.

QUESTIONNAIRE

1. Indicate your primary receiving area for MAC airlift shipments; and your name, title, unit, and Autovon number.

Primary Receiving Area

Name and Title

Unit and Autovon

(Answer the remaining questions with respect to MAC airlift for your primary receiving area.)

2. What percentage of your FY88–FY89 shipments did not meet your required delivery times? Please check the box that most accurately reflects your experience.

   ☐ Less than 2 percent late

   ☐ 2 percent–5 percent late

   ☐ 6 percent–10 percent late

   ☐ 11 percent–20 percent late

   ☐ Greater than 20 percent late.

(If you answered "less than 2 percent," you have completed the questionnaire. Otherwise, continue answering the questionnaire.)

3. In which fiscal year did you experience the most delays? Please check the appropriate box.

   ☐ FY88

   ☐ FY89

4. Specify six Transportation Control Numbers (TCNs) that represent particularly late shipments between March 1988 and October 1989.

   a. _____ b. _____ c. _____

   d. _____ e. _____ f. _____

5. Provide a case history for two of the TCNs selected in answer to question 4. You may provide a handwritten response. Please include the following in your answer:

   a. Shipment category, e.g., cargo, personal property, security assistance

   b. Required delivery date (if specified)

   c. Number of days or hours late

   d. Reason for lateness, e.g., MAC delay, not in stock, or late shipment from depot.

(You have completed the questionnaire.)